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ELECTRONARCOSIS

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ELECTRONARCOSIS*

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Recently there has been a constant increase in papers of varying length treating the effect on the nervous system of electric current in common use (Ranschburg, Panse, Lowenstein and Mendel, et al). They describe widely varying phenomena and constellations of phenomena, including symptoms resembling multiple sclerosis, paralysis, tabes, hallucinations and psychic disturbances. All researchers agree that the pathogenesis of these phenomena is still unknown, and in general there has been little clarification of their patho-histological basis. Regardless of how extraordinary it may seem, it must be admitted that methodical histological investigations in this field are still lacking; a few orienting studies have been made on modification of the brain tissue of individuals killed suddenly by electric current, of which I would refer only to the examinations of Jellinek and Spitzka, performed in the US on electrocuted criminals. However, even these are unsatisfactory, are not methodologically ^{correct} and especially, autopsies are lacking in cases in which the subject survived the incident for any length of time. A great deal more could be determined from the latter cases, and much more concluded about those areas of the nervous system which were damaged, than in cases of sudden death where serious functional disturbances have not yet developed naturally into recognizable morphological modifications.

Although so little is known of the effect on the nervous system of direct-, and alternating current in popular and practical use, even less is known of the effect of other types of current. Doubtless, within certain limits the latter also may have a damaging effect (i.e. small

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animals are killed instantly by a high frequency current), may promote life (i.e. according to Jellinek parrot eggs are maturated by high frequency current), or may become therapeutic agents, as illustrated by recent experiments in the treatment of progressive bulbar paralysis.

When a study of the effect of various types of current on the nervous system was undertaken on the basis of the foregoing, an intermittent current, the so-called Leduc current, was the first type considered.

In 1902, Professor Leduc of Nantes, showed through experiments on animals that a carefully administered, rapidly intermittent current produces a type of narcosis accompanied by total insensibility, which he named electronarcosis.

For producing an intermittent current, we used a Boruttan-type chronaximeter, with a disc ^{distribution} operated by the power network at 1,500-6,000 rpm. The disc is segmented by four equidistant insulators, producing four interruptions in the current with each revolution: 6,000 interruptions at a speed of 1,500 rpm, or 100 interruptions per second. The duration of the individual passages of current is easily measured in thousandths of a second (sigma) on an oscillograph. Direct current necessary for the experiment is supplied by a panthostat. One of the poles of the chronaximeter is connected to the positive pole of the panthostat; the remaining pole and the negative pole of the panthostat are connected to the electrodes. The well moistened electrodes are applied to the shaved skull and to the skeleton of the animal, the smaller electrode always applied to the skull. The current and voltage are readily indicated by an ammeter and voltmeter.

With a slowly increasing current, at approximately 4-8 μ a, 1,500 rpm, and 1-4 S [sigma ?], after 4-5 minutes some animals exhibit a peculiar quiescence and lassitude, and are overcome by a definite drowsiness; their eyelids droop, heads sag, and their eyes close (partial loss of tonus). In this state there is a slight drop in respiration. Otherwise, this state differs in all respects from both sleep and from narcosis. The

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Primary difference is that the muscles do not relax completely as in narcosis, but always exhibit a certain rigidity, especially in the extremities. Often, partial tonal loss, sagging of the head, and closing of the eyes does not occur. During sleep, pupils are contracted, while in this state the pupils are dilated, and usually react sluggishly. Often, the entire impression is that the animals are only in a certain stupor with a high degree of motor block. If the electrodes are secured to the animal, and the animal's position changed, the new position is retained for a long time. This is none other than experimental catalepsy (C. Keller, H. de Jong). In this state, the animals do not react to painful stimuli, i.e. they usually do not react to needle thrusts and according to some, operations such as serious cranial operations may be performed.

If the current is increased (10-30 μ a and 2-6 s), violent reactions appear, primarily in the vegetative nervous system: heavy salivation, great dilatation of the pupils, very rapid pulse, forceful ejection of urine and stool, discharge of sperm, etc. In addition to the ^{condition described above} ~~latter~~, there is a general tetanic muscular contraction, only partially interrupted by clonic spasms. If the current is turned off at this point, the animal at once opens its eyes, but does not react immediately to painful stimuli; and most interesting, holds even the most grotesque positions for long periods of time. I would term this state "post-narcotic" catalepsy. Despite threats, attempts to frighten it, and painful stimuli, including needle thrusts in the nose, the animal remains motionless. To a definite extent, this catatonial is analogous to human catatonia. The resemblance is heightened by the fact that there are also pronounced vegetative disturbances (viz. salivation) in human catatonia.

We subjected some of the animals to ^{a p. of} acute execution under narcosis, while the experiment was repeated over several days on others, and were not ^{killed} executed until weeks later.

In the ^{rapidly killed} ~~acutely executed~~ animals, hemorrhage was most striking. We observed extensive bleeding throughout the cerebral ventricles. There was also a great deal of subarachnoid bleeding, especially at the base

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of the brain. Bleeding was hardly noticeable in the parenchyma. The blood vessels were greatly enlarged: the terminal vessels, the arterioles, venules and corpuscles were swollen with blood, especially in the basal ganglia.

In the animals surviving the longest, the most radical modifications may be observed in the wall of the ventricles, especially the lateral ventricles and their surrounding structures (primarily the caudate nucleus); in any case, modifications are more marked here, than in the rest of the brain, namely the meninges \angle cortex ? \angle .

On the basis of the above, from a clinical viewpoint, it is without doubt that under "electronarcosis" a host of symptoms appear: drowsiness (c.f. to a certain degree Hess' experiments), unconsciousness, partial tonal loss, catalepsy, stupor, etc, and apparently an important component of the entire condition is an inability to move and react.

Leduc also performed experiments on himself with this type ^{of} current. In his procedure, he placed 14-16 layers of wet gauze on his forehead in lieu of an electrode, and a similarly fashioned electrode on his back. According to his account, speech centers are blocked first, then motor centers, until reaction is impossible even to all kinds of painful stimuli. If the current is intensified, according to Leduc's account, speech is heard as though through a dream. He writes that this condition is similar to a nightmare, in which one senses a horrible danger, but is unable to move or utter a sound. This personal observation of Leduc attests that this is not an actual narcosis. In narcosis, the functioning of nerve cells is eliminated through impairment: Here, however, we are faced with current-caused anxiety phenomena. Even if the above clinical symptoms are not considered, anxiety is indicated by the entire scale of vegetative symptoms which we observed, and the cataleptic phenomena are also actually anxiety symptoms, individual components of which are similar to a protracted condition of the brain ^{expressed in} with position-retention reflexes.

Considering the clinical symptoms observed, even on the basis of

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clinical experience amassed up to the present, we must conclude that the symptoms indicate agitation, i.e. alteration, of the structures in the walls of the brain ventricles. In our experiments, through histological procedures we then found that the ventricle walls and the structures surrounding them actually suffered the most. In my opinion, in the described experimental arrangement, the electric current follows the path of least resistance, ^{i.e. passes through} the (intraventricular) fluid, and naturally, the primary disturbance is in the ventricular formations.

Many interesting problems ^{arise} abound in connection with this type ^{of} current: viz. the behavior of arteries, the application or reference of Ricker-type arterial pathology to cerebral arteries, the pathogenesis of subarachnoidal hemorrhage, cerebral edema, ^{congestion} swelling of the brain ~~etc.~~, ^{and} tyrogolysis. ^{is precisely the existence of these} It was ~~these very problems~~ ^{of} which prompted me to begin experimentation with this type ^{of} current. In this paper, however, I must be satisfied with the above, from which it is evident that the Leduc narcosis is not a true narcosis but a complex of phenomena which only recently have come under wide study in neurology (sleep, consciousness, narcolepsy, tonal loss, etc.), and which apparently arise from excitation of different centers closely grouped at the base of the brain: furthermore, that intermittent current is dangerous, and at even relatively low current intensity can produce deep-seated changes.